DOCUMENT RESUME

ED 200 335 PS 012 105

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TITLE Minor Anomalies and Behavior in Different Home Environments.
PUB DATE Apr 81
NOTE 20p.; Paper presented at the Biennial Meeting of the Society for Research in Child Development (Boston, MA, April 2-5, 1981).

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Behavior Development; *Cognitive Development; *Congenital Impairments; *Family Environment; Longitudinal Studies; Measures (Individuals); Neonates; Parent Influence; *Perinatal Influences; Predictor Variables; *Young Children

ABSTRACT

This study presents research findings of a four year study intended to identify infant and family characteristics which, singly or in combination, predict developmental problems during preschool and school years. Predictors included a variety of measures of parental and neonatal biological conditions as well as measures of the quality of the social environment. These included tests of development and cognitive functioning (such as the Bayley Scales of Infant Development and the Stanford Binet Intelligence Scale), and assessments of social functioning based on parental reports. The initial sample consisted of 193 first-born infant/mother dyads who were enrolled in a pre-paid health insurance cooperative in Seattle, Washington. In general, correlations of weighted minor congenital anomalies scores with neonatal variables (birthweight, gestational age, and medical risk), behavior and cognitive measures, and level of home stimulation were all low. It was concluded that minor congenital anomalies are not important predictors of development during the course of childhood, given the important mediating effects of the psychosocial environment.

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Paper presented at SRCD, Boston, April 2, 1981.

SYMPOSIUM: MINOR PHYSICAL ANOMALIES: BEHAVIORAL AND BIOLOGICAL CORRELATES

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# Minor Anomalies and Behavior in Different Home Environments

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(Presented by Robert Telzrow)

The data to be discussed were obtained in a 4-year, continuing longitudinal study intended to identify infant and family characteristics which, singly or in combination, predict developmental problems during preschool and school years. Predictors included a huge array of measures of prenatal and neonatal biological conditions as well as measures of the quality of the social environment. Outcome measures include tests of development and cognitive functioning, such as the BSID and Stanford Binet, and assessments of social functioning based on parental report.

At the time the study was being designed in the early 1970's, there were a number of reports in the literature linking minor congenital anomalies to hyperactivity, more consistently in boys, and sometimes to decreased school performance. Therefore the inclusion of minor anomalies in our battery was accompanied by the hope that an anomalies score would prove to be a fairly simple, economical predictor of developmental problems, at least for boys.

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## METHOD

The initial sample consisted of 193 first-born infants and their mothers who were enrolled in a pre-paid health insurance cooperative in Seattle. Subjects were enlisted during prepartum appointments in the OB clinic. An effort was made to secure approximately equal numbers of women with twelfth grade education and less, and greater than twelfth grade education. An effort was also made to obtain equal numbers of subjects with and without any prenatal medical complications, such as vaginal

bleeding or excessive (or insufficient) weight gain during pregnancy. The result was a fairly heterogeneous sample with a 1972 income of $2,000 to over $30,000, education of 8 to 20 years, but skewed in an educated direction (mean years of schooling = 14 years, mean number of prenatal visits = 11.7 with 92 per cent beginning their medical supervision during the first trimester of pregnancy). The greatest attrition occurred during the first eight months, with 92 per cent of the original newborn sample available for one year follow-up. By age four, almost 88 per cent were available.

Although the initial plan was to examine for newborn anomalies, the assessment schedule in the hospital was too full to permit it. Furthermore, the puffy eyes of newborns made it difficult to examine epicanthal folds and it was difficult to examine hands without eliciting plantar grasps. Therefore assessments of mouths, hands, and feet were done at four months, and remaining assessments of ears, eyes, and head were done at eight months.

List of Anomalies and Weights
(Slide 1--Use Table 1 from J. Peds 1980 article)

Examiners were project nurses, trained to a 85 per cent agreement. Anomalies were weighted according to severity, consistent with the work of other investigators. The entire list was represented in our sample, with the exception of furrowed tongue. The most common (31%) was a curving fifth finger on the right hand. Weighted anomalies scores ranged from 0 to 9, with a mean of 3.22, and complete anomalies examinations were obtained for 164 infants.

## RESULTS

(Slide 2 - Correlations between Weighted Minor Anomalies and Neonatal Variables)

a. Minor anomalies were not associated with low birthweight in our sample. Inexplicably, the infant boys with higher weighted anomaly scores tended to be larger than those with lower anomaly scores. For girls, the correlation between anomalies and birthweight was in the expected direction, but disappointingly low.

b. As in the case of birthweight, lower Dubowitz gestational age estimates were not associated with higher weighted anomalies scores.

c. The medical risk variable is based on the presence of a medical risk factor during the prenatal, intrapartum, and/or neonatal periods. Medical risk factors during the prenatal period include such things as chronic urinary infection requiring daily medication or previous history of stillborn or neonatal death. There were no mothers with such important risk factors as needing insulin or seizure medication, drug addiction, or chronic alcoholism. Intrapartum risk factors included such problems as premature rupture of the membrane, primary C-section, meconium staining, or fetal heart tones below 120 or above 160 beats per minute. Neonatal period problems included, for example, Apgar of 6 or below at one or five minutes, low birthwight for gestational age, or birthweight below 2500 grams.

In order to reduce data, a 4 point scale was used whereby a high risk score of "4" meant a risk factor in each of these periods, and a low score of "2" meant no neonatal risk factors but some risk in one or both of the earlier periods.

This is a long explanation of a category that proved useless in terms of being associated with minor physical anomalies, but perhaps it is

important that anomalies were not associated with a common array of medical complications. On the other hand, one might not expect an association, since whatever causes medical problems that appear at the time of birth may be only remotely related to whatever causes minor anomalies early in pregnancy.

The next three variables are derived from the administration of the Brazelton Newborn Behavioral Organization Scale on day 2, and proved the most fruitful.

d. The 26 items of the Brazelton exam were rescored for each item on a three-point scale: normal, questionable, and deviant. These points were reached through joint decision by three staff examiners and Dr. Brazelton. The deviant behavior score used in Slide 2 is based on the number of behavioral items on which a "deviant" score was obtained, usually a score at an extreme of Dr. Brazelton's original nine-point scale. The range of deviant scores for each infant was 0 to 6, with 84 per cent having two or fewer deviant scores. It can be seen that for girls, the number of deviant behaviors was indeed related to minor physical anomalies.

e. The abnormal motor score is based on factor analysis of scores on Brazelton's Newborn Behavioral Organization Scale. Only the motor factor showed a significant association with minor anomalies. This score is based on the motor maturity and tremulousness items of Brazelton's Scale. Like the deviant behavior score, the abnormal motor score was associated with higher anomaly scores for infant girls in our sample.

f. The abnormal reflex score is based on the 20-item neurological examination section of the Brazelton exam and analyzed using the Lester clusters. Abnormal reflex scores were also associated with minor anomalies for girls and for the total sample.

Thus, in our sample, higher minor anomaly scores were associated with some newborn variables which might suggest some compromised developmental potential for the girls. No such association existed for the boys who, if anything, seemed perhaps more robust if they had higher anomaly scores! It seems that anomalies can, but not necessarily, be associated with developmentally "risky" characteristics.

By 1978 we began hearing suggestions that minor anomalies be used to screen infants for later behavior control problems, which concerned us because of the finding that anomalies are associated with hyperactivity in boys did not apply to all samples--most notably ours.

(Slide 3. Correlation of Minor Anomalies Scores with 12-36 mo. Behavior and Cognitive Measures)

Slide 3 shows the dismal results of our initial efforts to relate minor anomalies to development, and why we lack confidence in minor anomalies as a screening device.

The first four items are the Bayley Scales of Infant Development Mental and Psychomotor Development Indices at 12 and 24 months. The activity measures at 12 and 24 months come from examiner ratings of behavior on the Infant Behavior Record of the BSID. IBR items were factor analyzed, with seven factors identified. The Activity factor includes the tension, activity, body motion, and level of energy items of the IBR.

The PBQ (Preschool Behavior Questionnaire) is a questionnaire developed by Lenore Behar and Samuel Stringfield at the University of North Carolina and consists of 30 items which have been factor analyzed into 3 clusters which Behar calls hostile-aggressive, anxious, and hyperactive-distractible. Sample items include "Squirmy, fidgety child," or "Fights with other children." The higher the score on the PBQ, the more problem

behaviors the mother says the child has. Thus, the only significant correlation is that mothers of girls report fewer problem behaviors in daughters with more minor anomalies. The PBQ is the important behavior measure at ages three and four.

Fortunately we thought to reanalyze these depressing data according to what kinds of scores had been obtained on the Caldwell Home Observation Measurement of the Environment (HOME). The HOME Inventory contains interview and observation material gathered by a home visitor and samples the social, emotional, and cognitive support given to a young child. HOME Inventories were conducted at 12, 24, 36, and 48 months. The resulting paper was published in J. Ped. 5/80, and I don't want to belabor it here, except to point out major findings.

(Slide 4)

a. Children were divided into "high" and "low" home stimulation groups depending on whether their scores on the HOME Inventory were above or below the total group mean. There were no significant correlations at age three between cognitive measures, such as expressive language, and minor anomalies for children in either the high or the low home stimulation groups.

b. For girls and boys living in less stimulating homes, higher anomalies scores were associated with <u>less</u> activity at 24 and/or 36 months. In Slide 4, the hyperactivity and aggression scales of the PBQ were combined because they correlated highly with each other and because combining them was consistent with others' definitions of hyperactivity. Only for three-year-old boys living in relatively enriched environments was there the expected association of anomalies with hyperactivity. It's difficult to call these "advantaged" boys hyperactive, because their mean score on

the "hyperactivity" measure was actually lower than that of less advantaged boys with no or few anomalies.

We concluded that much caution was needed in making assumptions about cognitive development and behavior on the basis of minor physical anomalies and that the effect of early biological variables such as minor anomalies was undoubtedly mediated by the environment in which the child grew.

We attempted to see whether anomalies, in connection with some other biological variable, could be related to behavior independent of home environment. Slide 5 shows a Chi Square distribution of scores on the behavior questionnaire hyperactivity measure at age four for only those children with scores of 4 or higher on the minor anomalies measure, broken down according to whether they had "normal" or "suspect" reflexes as newborns. It appears that within the higher anomaly group there were fewer children with high activity-aggression scores among those who also had abnormal newborn reflexes, while relatively more hyperactive children were seen in the group with no abnormal reflexes at birth. A "high" hyperactivity score is one in the upper quartile of the entire distribution of 156 4-year olds, while a "low" score is in the lowest quartile. Distributions of hyperactivity scores at ages 2 and 3 showed no reliable differences according to whether the high anomaly children had normal reflexes at birth.

Similar Chi Squares were done at ages 2, 3, and 4 for children with weighted anomaly scores of 3 or less (i.e., low anomaly scores). At ages 3 and 4 children behaved rather similarly, with no differences seen between those with abnormal reflexes and normal reflexes in terms of whether they fell in a "hyperactive" or "inactive" direction.

However, at age 2, in these low-anomaly children, there were relatively fewer children described as "inactive" among those with suspect reflexes than among those with normal reflexes.

On the one hand, it's tempting to say that there's evidence that abnormal newborn reflexes are more frequently associated with activity than inactivity at age 2 among children with no or few minor anomalies, and that abnormal reflexes are associated with more frequent inactivity or caution at age 4 in children with more or more pronounced anomalies. However, the failure of these findings to be consistent at other ages plus the absence of a good explanation for the effects of anomalies and reflexes to be additive or mutually potentiating at age 4 gives us reservations until the same trends are seen in other samples. Due to sample size, it was not possible to do similar Chi squares according to home stimulation and sex variables.

As can be seen in Slide 6, the highly significant association of minor anomalies and reduced activity in less advantaged three-year-old boys was no longer seen at age four. Slide 6 includes all correlations significant at the 10 per cent level or better involving infant biological variables and four-year-old behavioral and cognitive measures. Infant variables included birthweight, which was unrelated to the later measures, reflexes (Lester scoring), and minor anomalies scores.

Higher anomalies scores were associated with lower total scores for disturbed behavior on the PBQ and with lower scores on the hyperactivity measure for less advantaged boys and girls combined, although the correlation was not significant at the 5 per cent level.

Abnormal newborn reflexes were similarly associated with lower total scores for disturbed behavior and hyperactivity for girls in less enriched homes.

The association of decreased motor proficiency and higher anomalies scores in less advantaged boys and girls had not been seen earlier on either the BSID motor scale or the motor items of the DDST. At age 4, motor performance was measured by the Motor Scale of the McCarthy Scales of Children's Abilities. A 2 (high and low HOME) x 2 (high and low anomaly score) ANOVA interaction indicated a significant difference in distribution of motor scores of children depending on level of home stimulation and anomalies.

The association of decreased expressive language with increased anomalies for children living in less advantaged homes was also a new finding at age 4. Again, a 2 (high and low HOME) x 2 (high and low anomaly score) ANOVA interaction indicates a significant difference in distribution of expressive language scores of children depending on home stimulation and minor anomalies. The lower expressive language scores were obtained by boys living in less stimulating environments and having relatively high anomalies scores.

Slide 6 also includes correlations of behavioral and cognitive measures with anomalies scores from assessments at 1, 2, and 3 years. Although the coefficients are generally not large, we were nonetheless struck by the different <u>signs</u> of these coefficients for the relatively advantaged and relatively disadvantaged groups of children. There is a consistent trend among less advantaged children for minor anomalies or sometimes abnormal newborn reflexes to be associated with less skillful or proficient behavior, or perhaps less ready means of confronting or impacting the social and physical environment through assaultive behavior, motor activity, or language. Nothing similar is seen in the group of children in more stimulating home environments. In this group there is

no hint of an association between anomalies and decrement in coping or confrontive skills throughout the first four years.

We set out to find one kind of problem--hyperactivity--associated with anomalies, and didn't find it. If anything, we found more of a trend in one group toward the opposite--inactivity or perhaps behavioral reticence. We are not able to say whether and at what point our "inactivity" is problem behavior in the sense that hyperactivity is generally thought to be a problem. According to our questionnaire behavior measure, the low activity-aggression scores mean virtual absence of problem behavior. Thus, we should perhaps think in terms of inactivity as a characteristic, reserving judgement about its problematic quality.

One possible explanation for the different relationships between anomalies and other variables in the two home stimulation groups may have to do with a very real tendency for anomalies and associated biologic variables to accompany a less assertively confident, more cautious and watchful style in many children. (Clinically, I believe this to be true of many smart, school-age, mildly neurologically-impaired youngsters.) In an environment in which there is less adult effort to provide organized learning opportunities of all kinds at a level suitable for the child's development and style, the less assertive, less active child may be at a greater disadvantage in learning new things than a child who interacts more freely with his environment. This would explain the negative correlations between anomalies and behavioral and cognitive variables in the low-home stimulation group. On the other hand, it might not be too farfetched to say that the more watchful, less active youngster may be more amenable and responsive to parental efforts at providing all those good learning experiences. This notion would be supported by the occasional

positive associations between anomalies and cognitive variables in children whose mothers received high scores on their efforts to provide supportive, cognitively enriching opportunities.

Trends in our data are consistent with the findings of the Kauai longitudinal study (Werner, Bierman, and French, 1971). In the Kauai project, perinatal stress had a deleterious effect on physical and intellectual status at 20 months. However, the effects of perinatal stress appeared to be greater among children whose parents were poor, had little education, or were unstable as compared to children whose parents were better off economically, better educated, and more stable. According to a review by Sameroff (1975), the results of the Kauai study seemed to indicate that perinatal complications were consistently related to development only when combined with and supported by persistently poor environmental circumstances. Given the characteristics of the Seattle sample, one would predict a generally poor relationship between infant biological characteristics and later developmental problems.

Some may recall reports in the clinical literature that the presence of three or more minor anomalies signifies some likelihood of the presence of a major congenital anomaly. If this is true, one would expect far more problems in our sample. Actually one list in the pediatric literature in 1964 (Marden, Smith, and McDonald, 1964) includes for the most part different minor congenital malformations with different criteria for identification of those seen on both lists. These malformations may indeed indicate the presence of a major disabling condition. Our initial attempt to get our data published in the pediatric literature was met coolly by editors who thought we were dismissing the importance of examining newborns for congenital malformations.

It is hard to know how much to interpret marginal findings which include lots of not-quite-significant correlations, especially since they differ from those of Halvorson, who reported higher anomalies to be associated with more activity in boys and less in girls. They also differ from another study by Jacklin, Maccoby, and Halverson reported this past year, in which there was a generally non-significant trend for anomalies to be associated with more activity in girls, rather than boys, at two to three years. Our conclusion is that minor congenital anomalies are unimportant predictors of development during the course of childhood, given the enormously important mediating effects of the psychosocial environment.

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Slide 1 List of anomalies and scoring weights

| Anomaly | Scoring weight |
|---|---|
| **Head** | |
| OFC $\geq$ 1.5SD above or below normal | 2 |
| Frontal hair whorls | 1 |
| **Eyes** | |
| Epicanthus | 2 or 1 |
| Inner canthal distance $\geq$ 1.5SD above or below normal | 2 |
| Inner canthal distance $\leq$ 1.0 & 1.4SD above or below normal | 1 |
| **Ears** | |
| Low seated ear | 2 or 1 |
| Adherent lobe | 2 or 1 |
| Malformed | 1 |
| Asymmetrical | 1 |
| Auricular length less than or equal to 3.5 cm | 2 |
| Auricular length 3.6 to 4.2 cm | 1 |
| **Mouth** | |
| Steepled palate | 2 |
| Flat-narrow palate | 1 |
| Furrowed tongue | 1 |
| **Hands** | |
| Fifth finger incurvation | 2 or 1 |
| Single transverse palmar crease | 1 |
| Bridged transverse crease | 1 |
| **Feet** | |
| Third toe longer than second | 2 |
| Third toe equal to second | 1 |
| Partial syndactyly | 1 |
| Gap between first and second toe | 1 |

## Correlations of Minor Anomalies Scores with Neonatal Variables

| | F | M | total |
|---|---|---|---|
| Birthweight | —.08(84) | +.23 (76)* | +.02 (160) |
| Gestational Age | -.12 (86) | +.05 (78) | -.06 (164) |
| Medical Risk | +.02 (86) | +.05 (78) | +.03 (164) |
| Deviant Behavior (Brazelton) | +.20 (86)* | -.07 (78) | +.07 (164) |
| Abnormal Motor (Brazelton) | +.21 (86)* | -.04 (78) | +.10 (164) |
| Abnormal Reflex | +.21 (86)* | +.07 (78) | +.14 (164)* |

*$p < .05$ level

## Correlations of Minor Anomalies Scores with Behavior and Cognitive Measures at One, Two, and Three Years

| | | F | M | total |
|---|---|---|---|---|
| BSID MDI | 1 yr. | -.09 (86) | +.18 (76) | +.03 (164) |
| BSID PDI | 1 yr. | -.05 (86) | +.06 (76) | .00 (164) |
| Activity | 1 yr. | -.13 (84) | -.02 (74) | -.09 (158) |
| BSID MDI | 2 yr. | +.02 (82) | +.06 (71) | +.05 (153) |
| BSID PDI | 2 yr. | -.01 (80) | -.05 (69) | -.05 (153) |
| Activity | 2 yr. | +.02 (82) | -.13 (72) | -.06 (154) |
| Expressive Lang. | 3 yr. | -.05 (81) | -.02 (69) | -.03 (150) |
| DDST motor | 3 yr. | -.05 (80) | -.06 (68) | -.05 (148) |
| PBQ Disturbed Behavior | 3 yr. | -.24 (83)* | +.02 (77) | -.13 (160) |

*$p < .05$ level

## Correlations of Minor Anomalies Scores with Behavior and Cognitive Measures by Level of Home Stimulation

| | | | Low HOME | High HOME |
|---|---|---|---|---|
| **Girls** | | | | |
| MDI | 2 yr. | | -.31 (32) | .00 (51) |
| Activity | 2 yr. | | -.43 (27)* | +.28 (47) |
| Expressive lang. | | 3 yr. | -.16 (29) | -.01 (52) |
| Hyperactivity-Aggression | | 3 yr. | -.30 (29) | -.09 (49) |
| **Boys** | | | | |
| MDI | 2 yr. | | -.09 (24) | +.21 (36) |
| Activity | 2 yr. | | -.45 (24)* | -.14 (37) |
| Expressive lang. | | 3 yr. | -.08 (25) | +.02 (44) |
| Hyperactivity-Aggression | | 3 yr. | -.61 (25)** | +.34 (45)* |

*$p < .05$ level

**$p < .01$ "

# Distribution of Activity Scores According to Newborn Neurological Status by Minor Anomalies Score

## Age 4 Anomalies Score 4 or greater

| Activity: | High | Medium | Low | total |
|---|---|---|---|---|
| Suspect Reflexes | 3 | 12 | 9 | 24 |
| Normal Reflexes | 10 | 18 | 3 | 31 |
| | 13 | 30 | 12 | 55 |

Chi Square= 7.19 (2) p=.03

## Age 2 Anomalies Score 3 or lower

| Activity: | High | Medium | Low | total |
|---|---|---|---|---|
| Suspect Reflexes | 8 | 22 | 2 | 32 |
| Normal Reflexes | 19 | 32 | 17 | 68 |
| | 27 | 54 | 19 | 100 |

Chi Square 5.[illegible] (2) p=.05

Correlations of Biological Variables with Behavior and Cognitive Measures at One to Four Years by Level of Home Stimulation

| Age | | Low HOME | | | High HOME | | |
|---|---|---|---|---|---|---|---|
| | | F | M | total | F | M | total |
| 4 | Mean Anomalies Score | | | 3.4 | | | 3.2 |
| | Disturbed Behav. & Abnorm. Reflex | -.32 (29)[a] | | | | | |
| | Disturbed Behav. & Anomalies | | | -.24 (55)[a] | | | |
| | Hyperactivity & Abnorm. Reflex. | -.34 (29)[b] | | | | | |
| | Hyperactivity & Anomalies | | | -.23 (55)[a] | | | |
| | Motor & Anomalies | -.36 (29)[a] | -.34 (25)[a] | -.35 (54)[c] | | | |
| | Express. Lang. & Anomalies | | -.58 (23)[c] | -.41 (52)[c] | | +.30 (41)[a] | +.18 (94)[a] |
| | IQ & Abnorm. Reflex. | | | | | | +.21 (97)[b] |
| 3 | Mean Anomalies Score | | | 3.1 | | | 3.3 |
| | Disturbed Behav & Anomalies | -.37 (27)[b] | -.63 (25)[c] | -.45 (52)[c] | | +.29 (45)[b] | |
| | Hyperactivity & Anomalies | -.30 (27)[a] | -.61 (25)[c] | -.43 (52)[c] | | | |
| | Receptive Lang. & Anomalies | -.26 (29)[a] | | | | | |
| 2 | Mean Anomalies Score | | | 3.1 | | | 3.3 |
| | Activity & Anom. | -.43 (27)[b] | -.45 (24)[b] | -.32 (51)[c] | +.28 (47)[b] | | |
| 1 | Mean Anomalies Score | | | 2.8 | | | 3.4 |
| | Activity & Abnorm Anomalies | -.26 (33)[a] | | | | | |
| | Motor & Anomalies | -.28 (33)[a] | | | | +.24 (46)[a] | |
| | "IQ" & Anomalies | | | | | +.32 (46)[b] | |

[a] $p < .10$ level [b] $p < .05$ level [c] $p < .01$ level